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The improvisation-efficiency paradox in inter-firm electronic networks: governance and architecture considerations

Benn Konsynski, Amrit Tiwana

Emory University, Atlanta, GA, USA

Correspondence:
B Konsynki, Emory University, Atlanta, GA 30322, USA.
E-mail: benn_konsynski@bus.emory.edu

Abstract

Being both facile and efficient are essential in contemporary enterprise systems that rely on distributed information across inter-firm boundaries. The need to achieve operational efficiency, while accommodating a continuous morphing of alliances and network arrangements, is a key challenge in the modern enterprise and market. Inter-firm interdependence and unpredictable market shifts heighten the need to establish an architecture and governance arrangement that permits needed adaptation. Fully integrated firms have increasingly morphed into networks of collaborators. The demand for efficient and effective inter-firm coordination is no longer a desired condition, but essential for competitive position. Historically, the cost of this efficiency has been loss of flexibility, yet volatile markets reward efficiency *and* flexibility. Market trends demand an ability to improvise in the marketplace – converge execution with planning – while being simultaneously efficient. In this paper, we explore this improvisation-efficiency challenge. The architecture and governance issues are considered that seek the strengths of both effects. Efficiency need not come at a high cost in attaining the ability to be adaptive and spontaneous. We explore the key considerations of both network architecture and governance structures that characterize improvisational networks. Trade communities and trading partners establish a discipline of processes and decision rights that serve the community of collaborators.

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Introduction

Successfully achieving and maintaining operational efficiency amid continuous change has become the prime vulnerability of the contemporary enterprise. The architectures that delivered efficiency often trivialize its capacity to adapt to evolving markets. Long-term viability belongs to firms that efficiently deliver products and services *that consumers need* and the markets demand. There are two challenges that undermine the capacity of enterprises to do so: (1) inter-firm interdependence and (2) unpredictable market shifts by definition cannot be anticipated. Delivering effective products and services is rarely a lone-wolf venture that it once was in the days when Ford owned even the rubber plants for manufacturing tires for its cars. Many products and services have become far too complex in their structures and delivery processes for it to remain viable for a single firm to efficiently and cost-effectively maintain capabilities for producing all of their constituent elements. With growing product and service complexity, individual firms specialize in a narrow domain and rely on a network of specialized business partners for complementary ingredients to their product and service offerings. Solo firms have increasingly morphed into networks of collaborators and co-conspirators – business partners, suppliers, complementors, and customers. This introduces inter-dependence across inter-firm boundaries and the key to managing such dependencies efficiently is effective inter-firm coordination. In relatively predictable markets, the emphasis has long been to maximize efficiency. Over the past four decades, firms have invested in nurturing inter-organizational information systems with the intent of squeezing out inefficiencies and increasing the efficiency of inter-firm coordination. A well-oiled extended

enterprise is able to minimize transaction costs. While many have achieved unprecedented levels of efficiency, paradoxically, the cost of this efficiency has been loss of flexibility. Volatile markets reward efficiency *and* flexibility. The current marketplace requires an ability to improvise in the marketplace – converge execution with planning – while being simultaneously efficient. The capacity to improvise shifts the playing field, not incrementally, but with a vengeance. Examples of network-embedded firms that have shown remarkable successes include the likes of Dell Computer and Amazon. Simple, static inter-firm networks that capture economies of scale are simply incapable of providing variety to a fickle market. The tradeoff of flexibility for efficiency is endemic in contemporary enterprise systems that efficiently but rigidly integrate distributed information across inter-firm boundaries.

In this paper, we explore this improvisation-efficiency paradox. We develop the key idea that a network can be improvisational and efficient if it achieves complementarities in architecture and governance design. We consider how efficiency-optimizing inter-firm IT architectures in which organizational operations are pervasively embedded present the biggest hurdle when firms need to make swift strategic moves. Efficiency often comes at the cost the ability to be adaptive and spontaneous. We develop the idea that managing the tension between adaptiveness and efficiency in inter-firm business networks requires attention to both their governance and their technological architecture. By governance, we refer to the business governance practices that orchestrate the network. By technology architecture, we imply the structural organizing logic that is used to design the inter-firm network. The architecture provides the enabling platform on which improvisational network capabilities are built and the governance practices systemically glue these capabilities at the network level. We explore the key considerations of both network architecture and governance structures that characterize improvisational networks. The two together are key to developing an ability of trading partners to establish a unique pattern of practice that serves the participating member firms in a unique and positive fashion. Trading partners establish a discipline of processes and decision rights that serve the community of collaborators. We then develop these ideas into a testable research model.

Organizing principles: architectures and governance practices

The utopia of the hypercompetitive market involves a business network that is proactive, dynamically flexible, yet efficient (Ilinitch *et al*., 1996; Volberda, 1996). It is smart and unbound by static form or function in exploiting emerging market opportunities. The 'smarts' in an improvisational inter-firm network are created by an interaction between its business practice element and a technical architecture element. This interaction differentiates the improvisational capacity of the network vis-à-vis the more mundane, statically programmed forms of networks. We expect to see attributes of agility, collaboration, self-organization, responsiveness, and other characteristics of cooperation in volatile markets. It is this market agility that demands an operational efficiency while tolerating a high degree of complexity and unpredicability. The majority of conventional electronic networks are planned and executed by trading partners along a fixed program of buyer and seller processes that serve the network membership (Rao *et al*., 1995; Lee *et al*., 1999). Some of the market processes and protocols are consensually defined, while others are imposed by the influence of buyer-side directives that impose a discipline on the seller communities. Such 'programmed' arrangements are of great interest as they dominate the scene of current smart business networks. The traditional organizing logic suffices if each firm's tasks are independent of others' and its outcomes are readily measurable. Volatile, unpredictable, and complex customer needs coupled with exogenous factors that vary unpredictably puts inflexible firms at the grave risk of becoming unnecessary in the marketplace (Ciborra, 1996).

For our purpose, we will focus on the form of improvisational inter-firm networks that are dynamically – even spontaneously – reconfigurable. We focus on the architecture that supports such networks and the governance of their operating environment. Rapid formation of partnering entities into a high-performance network is no small challenge. The idea of seamless connectivity across the extended enterprise (Hitt *et al*., 1998) is important but insufficient. Rapid and substantive reconfiguration is necessary in fickle environments (Aupperle, 1996). It is only with the employment of effective business governance policies and information technology architecture that we are able to have confidence in our ability to handle the complexity that attends such a pursuit. We consider how the guiding logic of contemporary inter-firm network architectures introduces strategic handicaps by maximizing efficiency but undermining flexibility. We consider how these organizing logics can be refined into adaptive business networks that maintain the capacity to explore new opportunities while exploiting existing ones. Improvisational networks must encourage fluid membership and active collaboration on roles, rights, and responsibilities. An effectively designed improvisational network is an intricate but coherently integrated blend of many different architectural and governance elements. Figure 1 summarizes the key architectural and governance elements of

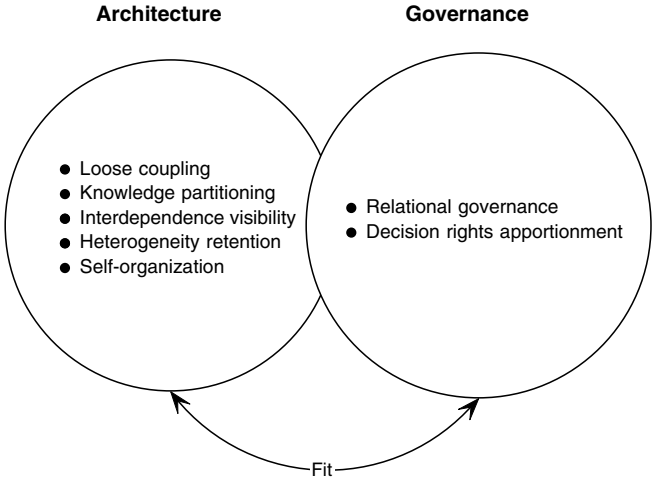

Figure 1 Two key elements of improvisational inter-firm networks.

such improvisational inter-firm networks, which are discussed in the following sections.

From alignment to aligning

Conceptualizing improvisational networks requires fundamentally thinking of aligning as a verb rather than alignment as a noun. Inter-firm network design is an ongoing process, not a discrete event. Aligning architecture, governance practices, and strategy requires synchrony between planning and execution, which many executives used to classical notions of strategy formulation find rather counterintuitive. When shifts in markets, partner portfolios, and products cannot be anticipated, inflexibility rears its head: The existing, hardwired inter-organization coordination technology becomes *the* bottleneck in adapting business strategy. An IT architecture that supports improvisation must therefore be inherently capable of being continuously realigned on an ongoing basis, over a period of time (see Figure 2). The key considerations that emerge in aligning interfirm networks are their structural properties or architecture and the governance policies within which they function. These are discussed next.

Architectural attributes of improvisational networks

Both the business environment and the technical environment define the limits of the possibility for formation of a spontaneous community and sustainable partnership. Architecture is the first element to be addressed here because it establishes the constraints within which feasible governance mechanisms are conceived. Architecture determines and constrains the apportionment possibilities decision-making power in the network. If architecture is thought of as the anatomy of the network, governance can be thought of as its physiology. The architecture of the network sets the framework for the other organizational design decisions. In this section, we enumerate a number of attributes and considerations that characterize the architecture that is needed to support the formation of inter-firm networks that remain improvisational. These reflect observations of environments conducive to ready adaptation

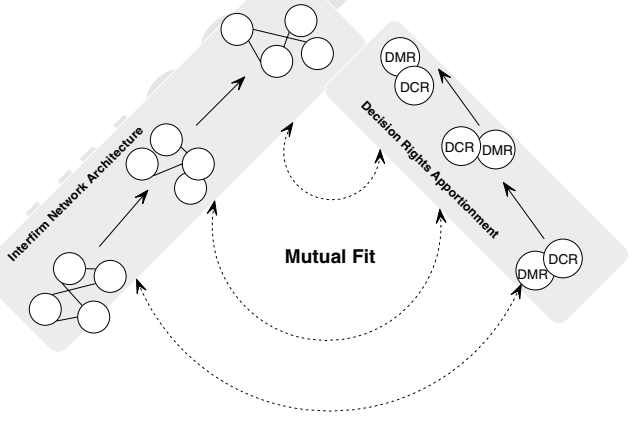

Figure 2 Mutual fit between improvisational network architecture and governance as an ongoing aligning process.

in response to – or in advance of – market shifts. Effective market practice includes attention to loose coupling and relevant modularization, a separation of knowledge sharing from process roles, increased visibility of operations across partnering organization, heterogeneity retention, and a self-organizing swarm architecture. We observe a continuous alignment of near and long-term objectives reflecting the different views of the participants, accommodation of heterogeneous interface, and active relational governance that frequently reviews roles and contributions to adjust behaviors. We consider each of these shifts in behavior as indicators of readiness to participate in spontaneous collaborative networks.

Process modularization

The relationships between firms in an inter-organizational network define its inter-organizational coupling (Orton and Weick, 1990). Coupling refers to how events in one member firm of the network affect the internal practice of another firm in the same network. Contemporary tightly coupled networks are built around partnering firms that have made complementary, dedicated investments that facilitate integration of information and business processes (Bensaou, 1997; Bensaou and Anderson, 1999). However, dedication to a given network can reduce flexibility in each participating organization as well as in the collaborative network. Improvisational networks require room to maneuver more freely while maintaining the integrity of inter-firm linkages. Consider a clothing manufacturer that can identify an emerging fashion trend and be the first to exploit it, irrespective of whether it currently has the capabilities to do so. This requires both an ability to draw in new organizations with the necessary capabilities that do not already exist in a network.

Clearly, this requires modularization of the inter-firm collaborative process itself. Modularity refers to the attribute of a system to shift interdependence between components to the interfaces between those components (Schilling, 2000). The key principle is that all interdependence between firms or entities in the network must be moved to the inter-entity interfaces and complete independence must simultaneously be maintained within each entity. This enhances flexibility in two ways. First, it makes the network entities semiautonomous by moving all coordination dependencies to the interface. Such autonomy allows each network member to choose how to accomplish its part of the overall task as long as there is considerable confidence that the contributions of individual network members will fit with each other. It allows process innovation as well as responsiveness. This is akin to the computer industry where a variety of manufacturers can use vastly different technologies to develop, say computer monitors. The common element that ensures compatibility is the use of standardized interfaces and connections. Inter-firm process modularization extends that logic to the execution of processes and activities that span firms within a business network. The key requirements are standardized definitions of interfaces at inter-firm boundaries so that different resources become self-describing, which allows them to be rapidly mixed and matched. Second, this forces thinking in terms of organizing around processes rather

than hierarchies or functional structure. Excessive attention to the boundary where one firm ends and another begins in a collaborative network can undermine the entire enterprise. Consider why this is a significant shift. On one hand, specialized and high-skill tasks require deep specialization within each firm in the network but on the other hand this deep specialization must be coordinated across the network in independent tasks. However, specialization also makes it difficult to integrate subtasks into the execution of network-level tasks – a need that modularizing these processes lowers. This process orientation facilitates thinking in terms of coordinating the contributions of network entities to the collective activity in improvising. The ability to execute a multi-dimensional decision process becomes a marketplace advantage that is difficult to replicate. Thus, loose coupling and process modularization strike a balance between the individuality and autonomy of network member firms and the ethic of the collective network.

Knowledge partitioning and redundancy

Business processes such as manufacturing, maintenance, and delivery are often partitioned among partner firms in business networks. For example, a focal firm might assemble a product, different parts of the product might be manufactured by various partners, another partner might market it, and yet another partner might provide after-sales support. A problematic assumption embedded in this approach is that firms confound the partitioning of business processes with the partitioning of the expertise that is needed to perform the tasks (Takeishi, 2002). An improvisational approach requires firms to treat the two as separate but interdependent approaches to specialization. On one hand, firms in improvisational networks must maintain deep specialization in the task domain but despecialize in their knowledge domain. Deeper task specialization means that specialist firms will develop deeper expertise beyond their specialized process and task domains and are therefore more likely to be attuned to technical advances and environmental shifts in those domains (Powell *et al*., 1996). Emerging field evidence in the Japanese automotive parts manufacturing business (Takeishi, 2002) and the global software industry (Tiwana, 2003) hints that such redundant knowledge facilitates more effective inter-firm collaboration. Such redundancy increases the capacity of individual firms to better relate to and coordinate with other firms in the network (Henderson and Clark, 1990; Zahra and George, 2002). In other words, it is useful for firms to have some understanding of their partners' domains for planning and execution of collaborative processes to converge. This distinction allows a network to reduce coordination complexities without compromising the benefits of specialization inside individual member firms. Therefore, redundancies in knowledge increase the absorptive capacity of the network by allowing members firms to specialize in their activities but despecializing in the knowledge that they internally maintain.

Inter-firm interdependence recognition and management

Recognition and management of changing interdependencies among business partners is another enabling role that must be played by the inter-firm network architecture. A large amount of communication and coordination is required to combine the activities when a large number of inter-related tasks distributed across the network are involved (Blacker *et al*., 2000). Information visibility in smart business networks is a useful mechanism for enhancing coordination, but only when inter-organizational interdependencies are relatively stable (Konsynski and McFarlan, 1990). As information access migrates, so does the interest in allocation of decision rights and decision authorities. With *Glasnost* comes *Perestroika*. Therefore, the inter-firm network architecture must allow visibility into member firms in the network for activities in which they have mutual interdependence. This raises the need for trust among partners and the threat of penalties for undermining that trust. These issues are of considerable importance but are outside the scope of this paper.

Heterogeneity retention

Although a variety of expertise is available to firms both internally and within their business network, contemporary firms are notorious for their inability to exploit such expertise when needed (Kogut and Zander, 1992; Grant, 1996; Kogut, 2000). The frequency with which this happens has led scholars to create a label for the phenomenon of fatal mis-steps that arise from not utilizing readily available knowledge or expertise: A 'glitch' (Hoopes and Postrel, 1999). The value-creating potential of inter-firm networks comes from the heterogeneity of individual member firms; each member is good at executing some activities but average at others. The strength of any inter-firm network thus is the variety and complementarity of expertise it can tap into in the decision-making and decision execution process. While managerial interventions can reduce the frequency of glitches, homogenization of the network eliminates their possibility as well as the possibility of novel recombinations of skills and expertise. Inter-firm business networks can gradually develop a degree of homogeneity, scale, and scope not unlike the vertically integrated firm. Homogenizing a network is a risky proposition: conformity should not be confused with homogeneity. Conformity to network norms can be created by modularization and governance mechanisms without losing heterogeneity.

Most new knowledge – new product ideas, creative process innovations, new technologies, and recognitions of emerging markets – is likely to be generated outside any given firm. The enterprise challenge is to recognize, appreciate, and exploit such shifts. However, some of these shifts might be so removed from existing organizational capabilities that a focal firm in a traditional business network will be under-equipped to do so. Heterogeneity then is a valuable attribute for flexibility although it *appears* – on the surface – to reduce efficiency. The trend towards relying on partner organizations to perform part of the value-creation function allows individual firms to squeeze more flexibility from their specialized expertise for one simple reason: it widens the repertoire of experiences and possible solutions beyond the routines, worldviews, and mental models of similar specialist member firms. This encourages exploration of divergent – sometimes unortho-

dox – perspectives in dealing in unpredicted market changes. In other words, retention of heterogeneity in the collaborative network broadens the locus of search for potential responses to yet-to-occur changes that remain elusive and unpredictable.

However, this organizing logic relies on islands of seamless coordination in a sea of heterogeneity. A firm with a loosely coupled approach to inter-organizational collaboration can organize to partner on the fly with other firms that have the complementary expertise, specialized assets, and complementary resources required exploit an emerging opportunity. The problem of being caught short of sufficient resource portfolios appears particularly pronounced in industries faced with turbulent technologies or markets. Case in point: Apple Music's move to position itself as an orchestrator for digital music sales in collaboration with five of the largest record companies. Nike's shoe business is another example of a product line fraught with uncertainties such as changing fashions, international laws, and global markets. Nike has retained the flexibility to reduce the idea-to-shelf time for introducing new shoe designs by encouraging its many suppliers to become more competent in *some* product design activities. However, by retaining the core design innovation activities in-house, it has both managed to make itself indispensable without homogenizing its collaborative network.

Self-organizing capability

Not unlike the hierarchical logic of organizing, partners in an inter-firm business network are usually deeply specialized in a narrow domain. Increased task specialization and simultaneous disaggregation of the locus of coordination means that each firm in the network narrows its internal focus by further deepening its expertise in a few selected areas while relying on network partners to invest in and develop specialization in complementary functional and technical areas. At the same time, higher levels of interdependence demand greater coordination using malleable rules for coordination. In effect, this reduces the capacity of each firm in the network to relate to the knowledge domain of its network peers. The key to compensating for these tensions lies in differentiating yet appreciating task partitioning from knowledge partitioning across firms in the network. Therefore mechanisms are needed to summarize, synthesize, and apply the knowledge flows across the network. Much of the weight of this task falls on the self-organizing ability of IT architectures. Self-organization refers to the organizing logic where activities are neither centrally controlled nor locally supervised (Bonabeau and Meyer, 2001). The capability for self-organizing through network-level knowledge management is embodied in two features of the IT architecture – shared meaning and swarm intelligence. Shared meaning refers to agreed upon 'vocabulary' to describe specialized concepts. These capture the subtle ambiguities that are not fully definable in, say, XML extensions. The challenge is not unlike electronic data interchange (EDI) systems except that such vocabularies evolve over time.

Most early automation efforts focused on taking thinking responsibilities from individual workers and putting them into information systems. The creation of the massive policy transaction systems that formed the back office of most life insurance companies saw tremendous substitution of computing power for human clerical work. Much of the early history of computerization was logged in accounting and finance – the factories of financial services. This automation was also largely static – that is, the dialogue between the system and the human cognitor was static. Regardless of the skill of the person interacting with the system, the machine always performed the same repertoire of cognitive acts. In cognitive reapportionment, there is a conscious design decision focused on the dynamic allocation of thinking responsibilities. The best analogy is the idea of delegation from superior to subordinate. When a superior delegates a decision, he or she gives up direct decision control, but reserves the right to re-take control. In cognitive reapportionment, the design consciously takes into account the ability to allocate decisions to people and/or systems with the ability to dynamically share, or even take back control. Thus, in certain situations the expert may be more interested in taking on cognitive responsibilities that might otherwise by handled by the system. In this sort of environment, the human being acts as a co-cognitor or computer as colleague. As computer support environments are more able to support this form of situational movement of decision capabilities from systems to humans, we will become more accustomed to sharing decision-making responsibilities in these human/system dialogues. Moreover, more of these human/system dialogues and more of their important details will be available for manipulation and design.

Swarm intelligence requires that IT architectures that support improvisation must be intelligent, but based on simple rules. The effect of a collaborative environment involves a forming of a proper community of decision makers and decision influencers. Spontaneous networks bring together those that have information and opinions and those that have decision rights and authorities. Thus, even the most primitive of nodes (such as passive radio-frequency tagged objects) cooperate and communicate with each other. Swarming through such embedded dumb tags allows cognitive reapportionment, that is, cognitive responsibilities can be allocated to a human or humans, or to a system or systems. It is the 'swarming' of information and expertise that may define the success or failure of improvisation in the network.

Governance mechanisms in improvisational inter-firm networks

Architecture is only one facet of inter-firm network design and many organizations overly focus on this at the risk of neglecting the governance policies that make it function in practice. The second ingredient of spontaneous collaborative networks are the governance mechanisms that establish protocols for attainment and severance of participation. In addition, the means by which participants make decisions on allocation of decision rights define the limits of the cooperation as a network system. Governance allows the network to transcend the formal attributes of structure, thereby strengthening its capacity for improvisation. Both the governance practices and the IT architecture need to be readied for effective participation in spontaneous colla-

borative networks. Two elements of governance are germane to the design of such networks: (1) relational approaches to governance and (2) re-allocation of selective decision rights across entity boundaries.

Relational governance

A firm, or market participant, makes decisions on resources, rights and authorities as an extension of the legal boundaries of the firm. The goals and objectives of the firm are projected into the external environment and patterns of influence are brought to bear to influence behavior of entities that extend beyond ownership – usually buyers creating discipline among seller communities. Smart business networks reap the flexibility benefits of specialization while distributing the locus of coordination across multiple partners. However, the absence of dedicated investments by member firms reduces the level of lock-ins to the network (Bensaou and Anderson, 1999), thereby creating threats of opportunistic behavior by individual firms in the network. Successful realization of such networks therefore demands higher levels of quasi-relational governance mechanisms based on mutual trust, market reputation, and strong relational norms (Dyer and Singh, 1998; Kale *et al*., 2000). The information architecture used to build improvisational networks should help reinforce such relational governance.

Decision rights apportionment

Decision rights allocation deals with location of authority that are associated with judgment and decision-making (Jensen and Meckling, 1995). At the core of the rights apportionment concept is the idea that decision responsibilities can be allocated to one or more participants in a network (Anand and Mendelson, 1997; Nault, 1998). Most early automation efforts focused on taking decision responsibilities from individual organizations and hard-wiring them into the network for allocation to the proper entity. The variety of knowledge needed to manage specialized decisions that require specialized knowledge overwhelms the cognitive capacity of the general manager in the locus firm. It is therefore sometimes suboptimal for one entity in the network to retain decision rights even when its own survival depends on effective exercise of those decision rights. A better alternative is to reapportion decision rights to network partners who have the best expertise to make the associated decisions but have traditionally lacked authority to make them. Failure to do so can impede the network's improvisational capability because there is simply not enough time to go up the hierarchy to a decision maker in the locus firm nor the requisite expertise. For example, retailers move critical merchandising decisions from their organization to their suppliers – offering decision rights for stocking and allocation that might historically have been perceived as an essential right of the retailer. Decision rights apportionment can be viewed as an attention conserving mechanism that preserves scare managerial attention from being directed to making decisions that are not appropriate given the available expertise at that locus of authority.

A useful framework for analyzing decision rights is the two-pronged classification developed by Fama and Jensen (1983): decision control rights and decision management rights. Decision control rights refer to the authority to set controls such as pricing, timing and schedules, and quality expectations for which each member firm will be held accountable. Decision management rights refer to the authority for deciding on how to implement actions that lead to those outcomes. It is instructive to separate the two types of decision rights and treat them differently in considering how to distribute the two types of decision rights in improvisational inter-firm networks.

The classic challenge in organizing is that the expertise needed to exercise a decision right might be located elsewhere from the decision right itself. The architecture of improvisational networks allows migration of information for decision rights exercise to the location of those decision rights in a fashion that is much more pervasive than extended enterprise networks. For example, swarming technologies such as RFID tagging devices, 'smart dust' transmitters, and global positioning technologies facilitate moving information from its locus directly to where decision rights ought to be located. In contrast, traditional disciplined enterprise architectures required that decision rights be located where information (rather than expertise or incentives) for those decisions resided. This flexibility requires fundamental rethinking in reapportioning the allocation of decision control rights and decision management rights in improvisational networks. We believe that organizations must begin by reconsidering reallocation of decision management rights before they reallocate decision control rights. This shift will allow entities with strong incentives for ensuring effective exercise of implementation aspects of decision rights (e.g., to suppliers and contractors) while retaining control in the locus firm.

Architecting improvisational capability

Historically, enterprise architectures have focused on the growth of hierarchies. In contrast, spontaneous collaborative networks add market-like attributes on top of hierarchy-reinforcing architectures. This allows firms in the network to engage in dynamic partnering of the nature that is typically found in spot markets, but without losing the efficiencies associated with hierarchical configurations. This shift is illustrated beginning with siloed architectures that preceded the more disciplined enterprise architectures in Figure 3.

The move from traditional organizational architectures to spontaneous collaborative networks requires an organizing logic in which the boundaries of the collaborative network are malleable. Malleability requires that firms that do not belong to the network at a given point in time and be brought in without the cost of dedicated technology investments by such prospective network participants. This form of network approach to partnering thus requires an inherently reconfigurable architecture. The enabling inter-organizational technology architecture must reflect this loose-coupling. Loose-coupling is not synonymous with decentralized processes. It is quite the opposite, where the processes are more tightly coordinated because the rigidity of the IT architecture is no longer a constraint. Four defining attributes of the inter-organizational information architecture enable this shift: (1) loose-coupling, (2)

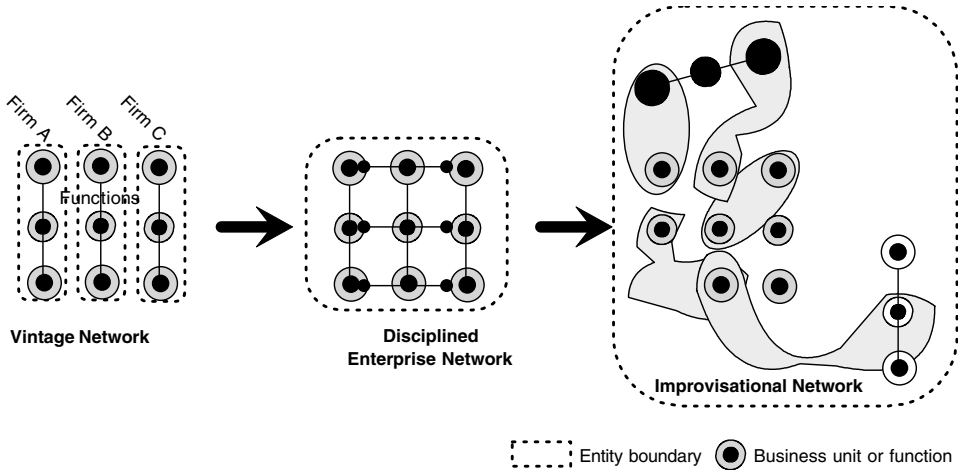

Figure 3 Towards Spontaneous Collaborative Networks.

swarming, (3) use of open standards, and (4) staged investments that create strategic real options.

Loose-coupling

Loosely coupled IT architectures are the building blocks of spontaneous collaborative networks. The looser the coupling in the inter-organizational architecture, the higher is the burden on the information technology architecture that is used to coordinate activities across a network. A viable loosely coupled architecture must be modular, which means that the interfaces among member firms in the network must be plug-and-play. Merely adopting open standards does not ensure such modularity. The design issue must be approached from a 1000 foot altitude systemic view. If implemented well, the payoffs of such architectures can be manifold. They allow member firms in a collaborative network to interconnect their existing systems both robustly and without the hurdle of dedicated investments in common systems. The resulting connections are inherently flexible, which allows any underperforming firms to be easily dropped from a product value chain or from the network and be replaced by a different one on an as-needed basis. Such flexibility is rarely possible in contemporary enterprise architectures because of the time lags and expense associated with rapidly integrating a new participant into an existing collaborative network. If glitches surface at any node in a complex collaborative network, a loosely coupled network can swap one firm for another on the fly. Such architectures therefore lend robustness to the collaborative network, wherein one underperforming participant does not bring down the entire network process.

Swarm intelligence

With embedded information technologies becoming inexpensive, the feasibility of pervasive tagging of objects is growing. This allows discrete objects to communicate with each other following simple rules; collectively, they create powerful swarming behavior that can be surprisingly smart. With inexpensive emerging technologies such as RFID tags, novel opportunities have arisen for firms to reconceptualize how individual firms collaborate with other firms as well as trillions of discrete entitites and objects in the extended network. We believe that this is one of the key technological architectural elements of SBNs.

Open standards

Standards and open protocols play a key role in architecting modularity into improvisational networks. Collectively agreed-upon but closed (non-public) standards tend to shrink the size of collaborative networks because each member must make dedicated investments in coordination technologies. Many of these investments are network-specific and carry limited redeployability outside a given network. EDI systems are a classic example of this tradeoff: partnering firms made dedicated investments in developing protocols, implementing systems, and increasing connectivity with a focal firm in the EDI network. A widely cited example is Wal-Mart's supply chain that uses deep, Wal-Mart-specific connectivity into its suppliers' systems. Emerging Web standards and protocols hold promise to change that. Open standards for business collaboration work in the same way as other open standards such as rail-track widths, USB interfaces, and electrical power outlet shapes. The most immediate benefits of open standards lie in their ability to extract more value from existing applications. The trick to making myriad existing systems, databases, and applications communicate using open standards is in using more recently Web-driven innovations such as eXtended Markup Language (XML) and Web services. The move towards complying with open standards does not necessarily involve accepting some kind of one-size-fits-all tradeoff. Industry-specific extensions to XML, for example, are being developed in the public domain by industry groups led by early adopters such as Dell, General Motors, and Merrill Lynch. As a result, variants of the base XML-type standards are further refined to meet the type of coordination requirements in specific industries. The same trends hold in related emerging technologies including IBM's computing-on-demand architectures. Their collective power lies in allowing trading partners to interact in unprecedented ways, but without imposing the rigid

precondition of having to make irrecoverable dedicated investments or scrapping existing systems. Together, open-standards and loose coupling enhance the modularity of the collaborative network architecture.

Incrementalism

Implementing improvisational networks requires considerable outlays to develop the technological capabilities discussed in the preceding sections of the paper. A key consideration is to maximize the potential upside while minimizing the downside risk of these investments. Thinking in terms of real options theory (McGrath, 1997; Bowman and Moskowitz, 2001), options must be embedded at each step of the implementation process. Such embedded real options are by definition more valuable when they are surrounded by considerable uncertainty and unpredictability. A key type of option that can be embedded during implementation is a 'staging' option (Trigeorgis, 1993). Staging refers to partitioning a larger IT investment into standalone increments that build on the preceding ones. In contrast, traditional IT investments follow a 'big-bang' approach: A new system is developed, tested, implemented, and finally turned on. The inherent risk in this approach is that the benefits of the investment begin only after the project is completed. If the business environment, markets, or technology change during the implementation trajectory, this approach cannot easily adapt to accommodate them. Moreover, if a project has to be abandoned halfway through implementation for any reason, there are almost no residual benefits from the sunk investments. This is illustrated in Figure 4. On the other hand, incrementally staged architectures mitigate this risk by delivering incremental, standalone benefits at each milestone (Panayi and Trigeorgis, 1998). Incrementalism therefore creates future option value and the total value of this option can be manipulated by choosing the sequence of staging investments in the architectural elements. Perhaps more importantly, incrementalism allows flexibility during the implementation process. At each stage, the plan for the following stages can be revisited and refined. At the level of the entire collaborative network, this attribute reduces the risk of creating prisoners' dilemmas among investing firms.

Towards a testable empirical model

The combination of increased coordination costs and reduced vulnerability lead managers to devise more complex network configurations. We identified several architectural and governance attributes of inter-firm networks that endow them with the capacity to be improvisational and efficient. The foregoing ideas can be summarized in an empirically testable model (Figure 5). The key hypotheses in the model are that the attributes of network architecture will influence network-level improvisational performance and that this relationship will be moderated by the two governance mechanisms vis-à-vis the degree of relational governance within the network and the extent to which decision management rights are delegated to member firms but decision control rights are centralized. In this model's conceptual development, we focused exclusively on the salient architectural elements of inter-firm collaborative architectures and business governance practices. Neither architecture nor governance ought to be downplayed because their interaction alone makes improvisation possible. For a network to be efficiently improvisational, its architecture and governance must be harmoniously aligned. However, we must be cognizant to the fact that there are other factors that might play into the equation. Two challenges must be noted in testing the model. First, little prior research has examined these constructs at the network level. This will require ground-up development of measures for the majority of the predictor variables. Second, the unit of analysis of this model is the inter-firm network itself, requiring extensive aggregation of data across member firms in each network. The superiority of a given network is merely in contrast with others that rival it. Therefore, performance of a given network must be anchored relative of other comparable networks to draw meaningful comparisons.

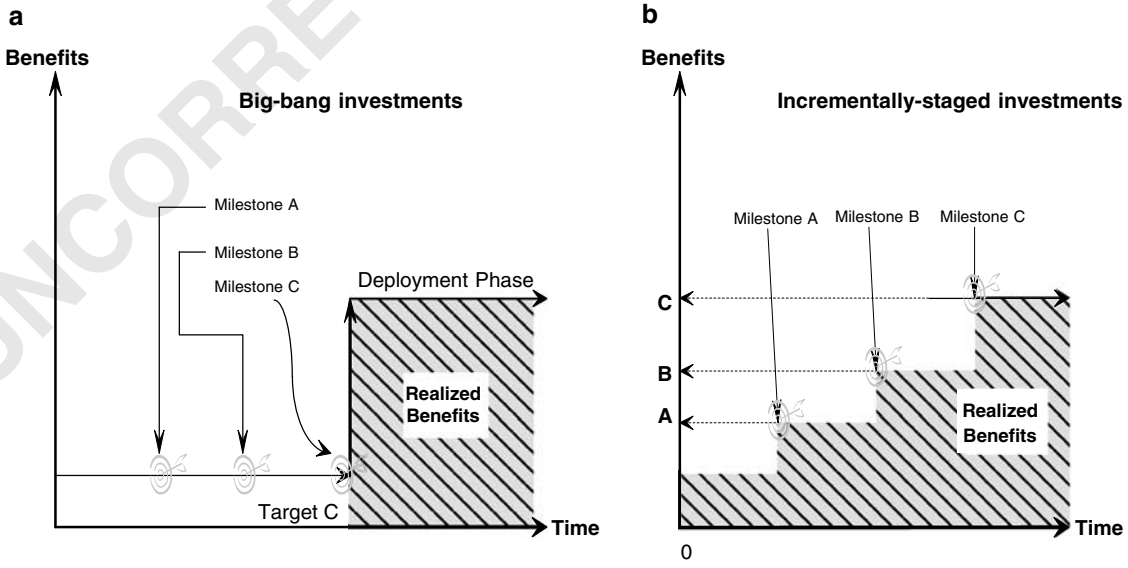

Figure 4 Big-bang investments *vs* incrementally staged investments.

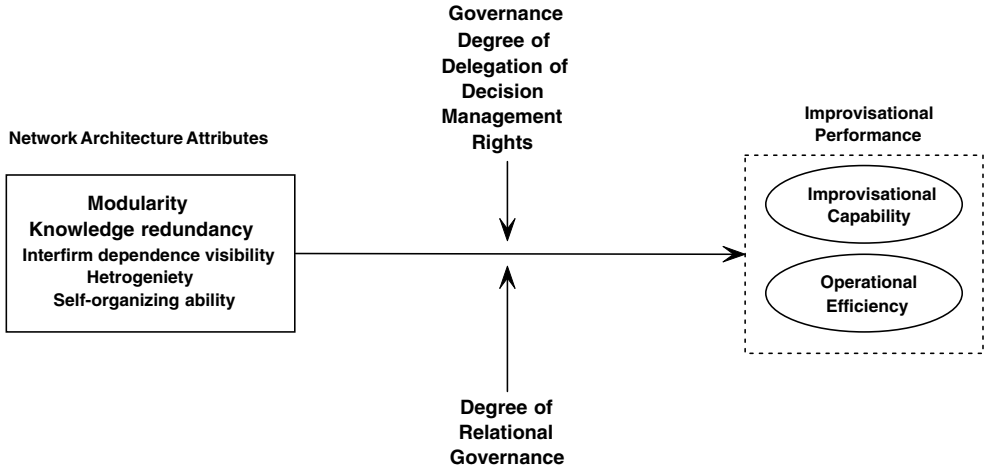

Figure 5 A testable theoretical model.

Viability of spontaneous collaborative networks

The design of an improvisational network alone cannot make it effective. Designing an architecture and establishing governance practice to complement it are the easy part; getting acceptance of the required policies are more likely to be a greater challenge. Its effectiveness depends on the strategic fit of the design with the business needs of the network as well as commitment from member entities for its implementation. A dominant hurdle in the latter instance is pre-existing organizational culture in individual member firms, which is best viewed as a static variable and is malleable only to a limited degree. Design policies are controllable by management but culture is not. No blueprinted prescriptions can or should be attempted to be generated because the congruence among the two is idiosyncratic to a given collection of participating firms.

Developing a deeper theoretical understanding of these issues requires attention to three questions in future research. First, how can participating member firms rely on network partners without diluting their ability to implement their own competitive strategies? Second, to what extent can they err on the side of overspecialization while trusting their partners to supply the complementary capabilities that can make or break their firm? Realizing an improvisational network is an expensive proposition and it should be viewed as an investment in creating real options that can be exercised in the future. How can individual member firms be confident that informal and relational governance contracts will be honored? Can the technology embedded in the network facilitate this? Improvisational inter-firm networks present an unprecedented phenomenon at the intersection of technology design and strategy. Further research can lend insights into how interdependent but autonomous firms can simultaneously achieve market focus and efficient scale.

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About the Authors

Benn R. Konsynski is the George S Craft Professor of Business Administration for Decision & Information Analysis at the Goizueta Business School at Emory University. He holds a PhD in Computer Science from Purdue University.

Amrit Tiwana is an Assistant Professor in Decision & Information Analysis at the Goizueta Business School at Emory University. He holds a PhD from Georgia State Univeristy. Professor Tiwana is currently in transition to Iowa State University.